Ellerbe Creek Watershed Improvement Project Overview

From your City Project Manager, Sandi Wilbur
Protecting Water Through Watershed Improvement

Clean water is important to us all. The City of Durham wants to help keep our creeks, rivers, and lakes safe for recreational activities, aquatic species, and ultimately, drinking water. As a result of decades of growth and development, our urban waterways have been affected by a variety of natural conditions, such as flooding and erosion, as well as man-made factors that include land development and road construction, sanitary sewer expansion, wastewater discharges, vehicle and power plant emissions, littering, landscaping and lawn care, resident animal population, and other activities.

To protect our rivers, lakes, and land areas, we must protect and maintain the health of our watersheds - the land areas and their network of creeks that contribute stormwater runoff to a common body of water. Protecting and improving the health of Ellerbe Creek is the primary goal of

Ellerbe Creek Watershed Improvement Project Goals:

Revitalize the health of Ellerbe Creek and comply with water quality regulations

- Assess current stream and watershed conditions
- Identify and prioritize Best Management Practices and stream restoration projects
- Improve or prevent further deterioration of water quality conditions

Pilot Study Area (PSA) Evaluations

The Ellerbe Creek watershed was subdivided into 33 smaller subwatersheds. Each subwatershed has a unique mix of land use types, ranging from highly developed to largely undeveloped. Five subwatersheds (# 1, 8, 17, 24, and 30), which are representative of the conditions found throughout the watershed, were chosen as pilot area studies for more detailed analyses of the water quality benefits of stormwater BMPs and stream restoration projects, as shown in Figure 1. The results of the detailed analyses were then projected to the other subwatersheds that had similar characteristics to evaluate the potential benefits to the entire watershed.

Table 1: Pollutant Load Reductions Based on Pilot Study Area Evaluations

PSA	Total Nitrogen	Total Phosphorous	Sediment	Fecal Coliform
1	20%	20%	37%	13%
8	8%	12%	18%	<1%
17	3%	3%	3%	<1%
24	10%	15%	28%	1%
30	N/A	N/A	N/A	N/A

Note: Load reductions are based on estimated pollutant loads under future land use conditions with project implementation occurring over the next twenty years.

Within each pilot study area, potential watershed improvement projects were rated for their efficiency (i.e., water quality benefits per dollar spent). Projects that performed well were selected for the pilot study area evaluations; less efficient projects were removed from further consideration. The overall pollutant removal efficiency for each pilot study area, shown in Table 1, is based on the combined performance of the recommended projects within that specific pilot study area. For example, eleven potential water quality improvement projects (e.g. water quality retrofits, water quality improvement practices, stream restoration) in pilot study area result in a 20% reduction in pollutant loads for nitrogen and phosphorus, a 37% reduction for sediment, and a 13% reduction for bacteria. Since pilot study area 30 is predominately undeveloped, water quality benefits will likely be achieved through implementation of the City's new Stormwater Performance Standards for Development rather than through BMP retrofits and stream restoration projects.

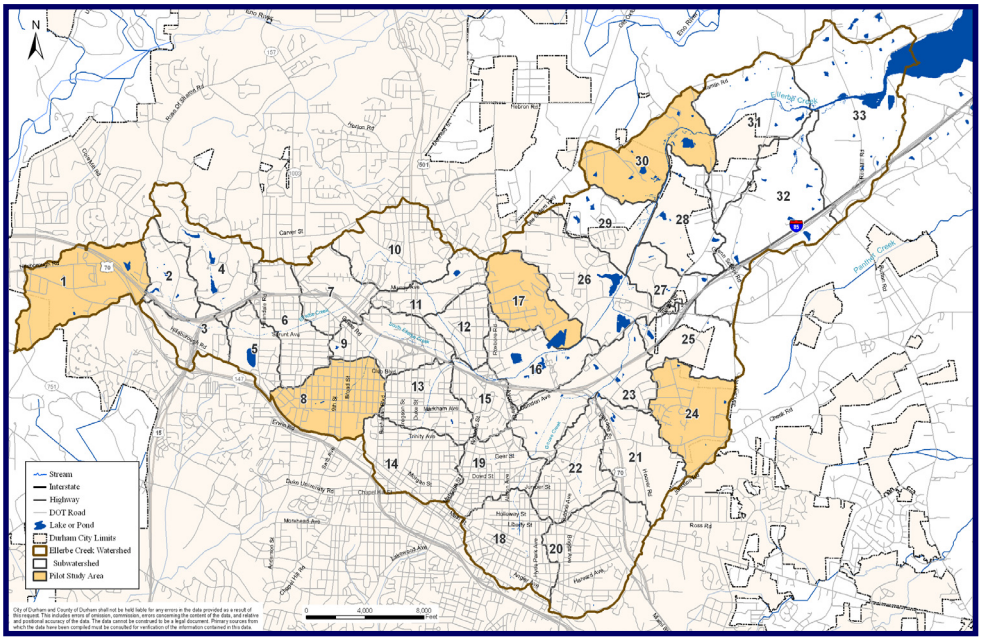


Figure 1: Pilot Study Areas

Evaluations of Non-Point Source Controls

Non-point source pollution *occurs when rainfall runs over land or through the ground on its way to streams and lakes, picking up pollutants like fertilizer, oil, and sediment.*

Point source pollution *can be traced back to a single source such as a sewage treatment plant or industrial discharge.*

In addition to the evaluation of retrofit and new BMPs and stream restoration projects, three more non-point source control measures were evaluated for their water quality benefits and costs:

1. **City's Stormwater Performance Standards for Development:** requires on-site water quality treatment for sediment and nutrients (e.g., nitrogen, phosphorus) for all new development and most redevelopment projects in the watershed that exceed 1 acre for single-family residential land use and ½ acre for other land use types. Water quality benefits for the Stormwater Performance Standards for Development were estimated by applying the on-site treatment requirements to all undeveloped parcels that met the ordinance's size threshold and to areas expected to undergo redevelopment identified by the City's Planning Department.

2. **Proprietary Stormwater Quality Treatment Devices:** consist of stormwater BMPs that are designed, manufactured, installed, and typically maintained by private companies. Proprietary BMPs (such as tree box filter) are becoming increasingly common in highly urbanized areas where the drainage system is primarily piped and space is limited for more traditional but land-intensive BMPs such as ponds and wetlands. Proprietary BMPs were evaluated to determine the potential water quality benefits and costs as retrofits to the existing storm drainage system in highly urbanized areas (e.g., central business district).

3. **Low Impact Development (LID) Practices:** LID practices, such as bioretention areas and pervious pavement, can be very effective stormwater management tools. They improve water quality by reducing he volume of stormwater runoff, reducing the amount of impervious cover, increasing preservation and protection of natural areas, and enhancing infiltration of stormwater runoff. Better Site Design and LID practices are important. A summary of the results from this project's LID evaluations is provided on Page 3.

Potential pollutant load reductions from implementation of the City's Stormwater Performance Standards for Development and from proprietary stormwater quality BMPs are presented in Table 2. The results are based on these controls applied independently of other non-point source controls.

Table 2: Non-Point Source Controls

Controls	Pollutant Load Reduction at Falls Lake				Approx. Public Cost (Present Value)
	Total Nitrogen	Total Phosphorus	Sediment	Fecal Coliform	
Stormwater Performance Standards for New Development	5%	5%	3%	1%	By Developers
Proprietary BMPs	5%	7%	13%	10%	$103 - $110 Million

Note: Load reductions are based on estimated pollutant loads under future land use conditions with proprietary BMP implementation and redevelopment occurring over the next twenty years. Maintenance costs for proprietary BMPs are not included.

Point-Source Controls

Three sewage-related point source controls were evaluated for pollutant removal potential: (1) eliminating sanitary sewer overflows, (2) eliminating improper connections to the stormwater system, and (3) installing upgraded nutrient control technology at the North Durham Wastewater Treatment Plant (WWTP), which discharges into Ellerbe Creek near the city limits.

To determine the effectiveness of these point source controls, staff estimated that sewer rehabilitation and the on-going efforts to identify improper sewer connections could eliminate 85 to 100 percent of the current sanitary sewer overflows and illicit connections.

Potential pollutant load reductions from these point source controls are presented in Table 3. The results are based on these controls applied independently of the non-point source controls.

Table 3: Point Source Controls

Controls	Pollutant Load Reduction at Falls Lake				Approx. Public Cost (Present Value)
	Total Nitrogen	Total Phosphorus	Sediment	Fecal Coliform	
Sanitary Sewer Rehabilitation / WWTP Reductions	4%	19%	0%	57%	$35 - $50 Million

Note: Load reductions are based on estimated pollutant loads under future land use conditions with project implementation occurring over the next twenty years.

Watershed Scenarios

In order to determine the benefits of the non-point source and point source controls on the overall water quality and watershed health of Ellerbe Creek, a GIS-based water quality model was developed and applied. The Watershed Improvement Plan (WIP) Tools is a GIS-based water quality model used to evaluate water quality conditions and help develop watershed improvement plans for the City. The WIP Tools model gives the City the ability to interactively review and evaluate the water quality benefits and costs of each individual stream restoration and stormwater BMP project based on the prioritization criteria established for this watershed. The WIP Tools model also enables the City to combine individual projects into a watershed management scenario and evaluate its overall effectiveness. Two watershed management scenarios were evaluated for their water quality benefits and costs. The results of two watershed scenarios are shown below.

1. **Combined Non-Point Source Controls:** consists of the combined effects of three non-point source controls: (1) pilot study area evaluations, (2) implementation of the City's Stormwater Performance Standards for Development, and (3) installation of proprietary stormwater BMPs
2. **Combined Non-Point Source and Point Source Controls:** consist of the combined effects of the three non-point source controls listed above with two point source controls: (1) elimination of SSOs and improper sewer connections, and (2) upgrades to the nutrient removal technology at the North Durham WWTP

Table 4: Water Quality Benefits of Watershed Management Scenarios

Scenario	Pollutant Load Reduction at Falls Lake				Approx.Public Cost (Present Value)
	Total Nitrogen	Total Phosphorus	Sediment	Fecal Coliform	
Combined Non-Point Source Controls	13%	15%	23%	6%	$320 - $370 Million
Combined Non-Point and Point Source Controls	31%	34%	23%	63%	$360 - $420 Million

Note: Load reductions are based on estimated pollutant loads under future land use conditions with project

Potential pollutant load reductions from implementation of these two watershed management scenarios are presented in

Better Site Design and Low Impact Development (LID) Practices

The applicability and effectiveness of Better Site Design and LID practices was examined in the watershed and throughout the City. Following the review of the LID literature and consideration of the constraints presented by Durham's geology and soils, a draft report was prepared documenting: (1) Recommendations of LID practices most applicable to the City of Durham; (2) Identification of target Ellerbe Creek subwatersheds for LID implementation; (3) Evaluation of potential benefits of LID implementation in one of the Ellerbe Creek Pilot Study Areas, and (4) A comparison of LID ordinances from other municipalities and recommendations for LID provisions in Durham's ordinances.

Using Pilot Study Area #1 (western end of the Ellerbe Creek watershed) as an example, alternative LID practices were examined to estimate how effective they are at reducing the volume of stormwater runoff and controlling the peak discharges from the area. In addition, estimates of the cost and pollutant reduction effects of alternative LID measures were prepared.

Table 5: Summary of 2-year, 24-hour Storm Model Results in Pilot Study Area 1 for All LID Scenarios

Scenario	Percent Impervious	Peak Flow (cfs)	Volume at Outfall (MG)	Notes
Existing Conditions	23.4%	306	19.3	Existing land use
Baseline Scenario (No LID improvements)	32.2%	406	23.7	Future land use with no LID improvements
Likely LID	**29.6%**	**380**	**22.5**	**Expected LID improvements**
Aggressive LID Enrollment	24.6%	328	20.2	LID applied everywhere possible with likely runoff reduction
Aggressive LID Runoff Reduction	27.5%	359	21.5	LID applied with likely enrollment with highest expected runoff reduction
Aggressive LID Enrollment & Runoff Reduction	19.7%	269	17.9	LID applied everywhere possible with highest expected runoff reduction

Table 5 presents an example of the impacts of the implementation of LID measures to stormwater runoff from Pilot Study Area #1 for the 2-year, 24-hour storm under five different LID scenarios. Note from the table that future development in the area, under current ordinances and development standards, can be expected to increase runoff volume by approximately 33% (from 306 cfs to 406 cfs) and total runoff volume by 22% (from 19.3 MG to 23.6MG). Under what are thought to be reasonable expectations for LID implementation the future peak discharge and runoff volume are reduced to 380 cfs and 22.5MG, respectively. A very aggressive, though not likely cost-effective, LID approach could be expected to reduce future peak discharges and runoff volumes below current conditions.

Critical Area Protection Plan

The Critical Area Protection Plan was developed for Ellerbe Creek to identify high-value properties to purchase and preserve. Protecting undeveloped properties located along the main stem or tributaries of Ellerbe Creek can protect water quality, prevent pollutants from entering the stream, protect valuable aquatic habitat, and provide recreational opportunities. Critical areas for protection were identified using 17 site selection criteria based upon existing site conditions, water quality and ecological benefits, and connectivity to other protected natural resources. Site characteristics from candidate sites were gathered from a number of resources, including: (1) Ellerbe Creek Local Watershed Plan; (2) the Durham Trails Master Plan; (3) the Falls Lake Initiative Conservation Plan; (4) land use data provided by the City, and (5) supplemental information obtained during the stream field inventory. Based on the watershed evaluation, seven high-priority areas in the watershed (see Figure 3) were identified where the City should focus initial efforts at acquisition and protection.

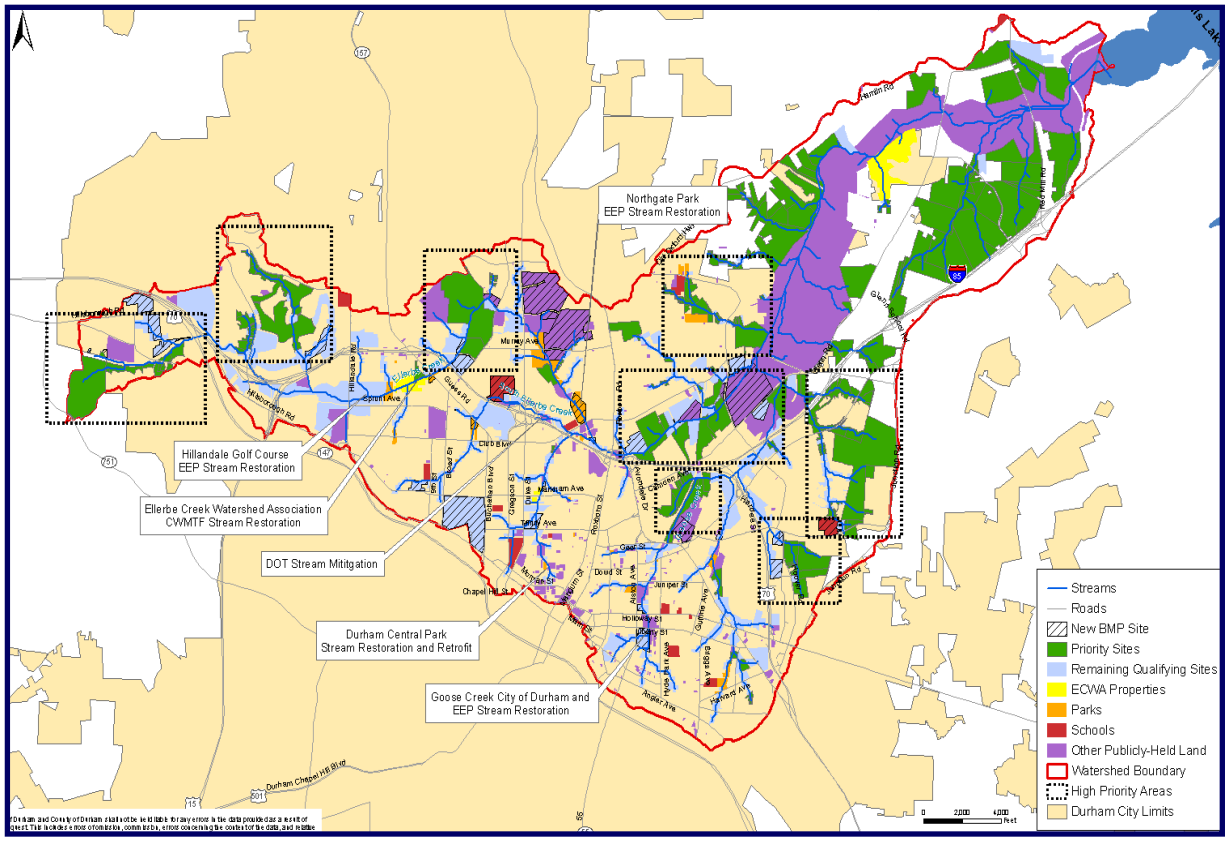


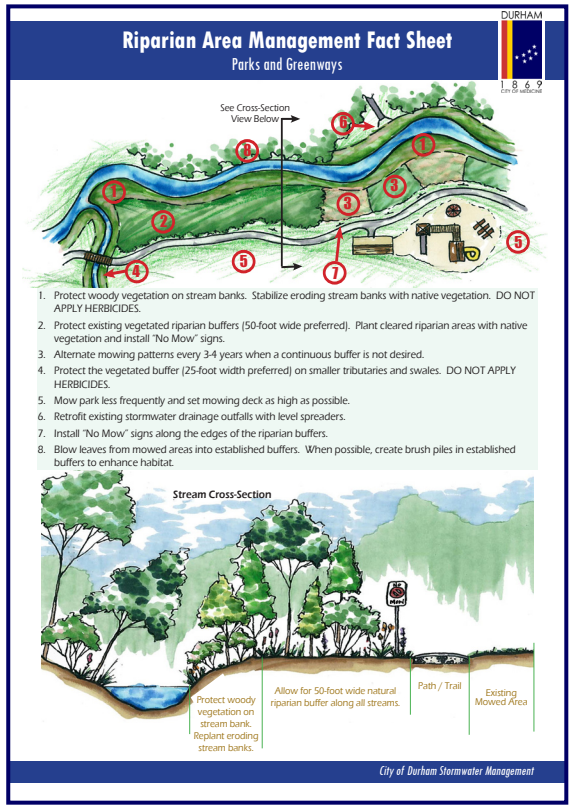
Figure 2: High Priority Areas for Critical Area Protection Plan

Riparian Area Management Plan

A riparian area management plan for City-owned property was developed for management, design, and maintenance staff, documenting:

- Vegetation maintenance guidelines and strategies for City staff along greenway trails, sewer and water easements, streams, and parks;
- Water quality and ecological benefits of the proposed riparian area management procedures;
- Invasive species management plan; and
- Planning and design guidance for managers and engineers.

Two Fact Sheets for operations and maintenance crews were prepared to reference while maintaining easements. One Fact Sheet features Best Practices for streambeds in parks and the other focuses on stream crossings located along Utility easements maintained by the City. Shown right, is the front of the City's Parks Fact Sheet illustrating both an aerial and cross-section view of desired riparian area management.



For more info about the Ellerbe Creek Watershed Improvement Project visit the web site:
www.durhamnc.gov/stormwater